Warehouse Operations Revisted

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Chapter 9

Summary

English Summary

In today's e-commerce continuous technological development, high competition, and especially high service standard requirements pose major challenges for the logistics operations of a company. Especially warehouses, which are responsible for the storage of goods, which are picked, packed, and shipped in response to customer orders, are requested to adjust their operations due to recent developments. High product return rates are one of those phenomena that complicate logistics operations. Significant return rates have become common for many companies and can, depending on the product category, be very high. For consumers the opportunity to shop online is usually accompanied with very liberal return policies, which induces those high return rates. Returned products in warehouses need to be unpacked, inspected, and re-integrated in the warehouse stock before they can be resold. With an increasing number of returns the processing becomes labor intensive so that the need for well-performing methods to deal with returns is prominent. This motivates reconsideration and redesign of traditional logistics processes which facilitate logistics efficiency on the one hand, as well as quick and reliable deliveries on the other hand.

The first chapters of this dissertation deal with order picking operation problems in warehouses of companies which face high return rates. Order picking operations contribute to more than 55% to the overall operation costs of warehouses. We show that when product returns arrive at the warehouse next to customer orders, there is a potential to save labor costs by integrating the two flows in some warehouse processes. Order batching and order picker routing are two warehouse problems that apply to both order picking and returns processing, which suggests to integrate the product flows. With batching a number of requests is grouped

into smaller sets each of which to be picked in one route, which in turn facilitates an efficient order picking process. If those requests consist of not only customer orders but also product returns, larger batches can be formed than the transport capacity would actually allow, if only the batch consists of the right mix of orders and returns. In Chapter 3 we considered the problem of batching a number of customer orders together with product returns in order to achieve quick order picking, while orders and returns are processed together in order to save time and costs. Order picker routing, which we discussed in Chapter 4, allows for an integration in a similar manner. Once a batch of orders and returns has been found, the order picker must be routed not only with the shortest possible route, but also under consideration of the transport capacity. We presented a well-performing method to determine such routes and also studied the impact that a specific mix of orders and returns in batches has on the quality of solutions.

In Chapter 5 we discussed the opportunity to consider the order batching and order picker routing problem holistically. Obviously, the two problems are interrelated and the performance of one method depends on the performance of the other. While sticking to context of integrated order and return flows, we proposed a model to also integrate batching and routing and presented a solution method to solve large-scale problems.

In Chapter 6 and 7, we focused on another important driver of warehouse costs, namely staff planning. We studied a staff planning problem for warehouses in situations of high workforce demand fluctuations, which are - just like product returns - a common issue and problematic for e-commerce retailers. Labor is usually highly cost-intensive and has to be used most efficiently by optimal scheduling. We discussed five optimization approaches to incorporate risk management in a staff schedule optimization problem and presented a decision tool for warehouse managers which can assist them in deriving low-cost solutions by simultaneously controlling risks of shortages.

Overall we addressed in this thesis a number of problems, which arise in many warehouses of e-commerce retailers and presented suited solution approaches for those problems. The performance of our designed algorithms we demonstrated by means of numerical experiments and partially by considering real-life situations. Our experiments showed that significant cost savings can be achieved by integrating incoming and outgoing product flows in warehouses, as well as by combining and jointly solving interrelated warehouse problems.